

That which is claimed is:

1. A planar inverted F antenna configured for operation at an operating frequency band, the planar inverted F antenna comprising:
  - 5 first and second antenna segments wherein the first and second antenna segments are separated by at least approximately 3 mm;
  - a third antenna segment coupling the first and second antenna segments;
  - a reference voltage coupling on the first antenna segment; and
  - a feed coupling on the first antenna segment, wherein a current null is present
- 10 between the feed and reference voltage couplings at the operating frequency band.
2. A planar inverted F antenna according to Claim 1 wherein the feed and reference voltage couplings are separated by at least approximately 15 mm.
- 15 3. A planar inverted F antenna according to Claim 1 wherein the first and second antenna segments are rectilinear and parallel.
4. A planar inverted F antenna according to Claim 3 wherein the third antenna segment is coupled to the first and second antenna segments at ends of the first and
- 20 second antenna segments.
5. A planar inverted F antenna according to Claim 1 wherein the feed coupling is spaced apart from the third antenna segment by a greater distance than the reference voltage coupling.
- 25 6. A planar inverted F antenna according to Claim 5 wherein the first and the third antenna segments define an angle of approximately 90 degrees.
7. A planar inverted F antenna according to Claim 1 wherein the first antenna
- 30 segment is longer than the second antenna segment.
8. A planar inverted F antenna according to Claim 1 wherein the operating frequency band is in the range of approximately 1700 MHz to 2500 MHz.

9. A planar inverted F antenna according to Claim 1 further comprising:  
a printed circuit board including a reference voltage conductor and an antenna  
feed conductor, the reference voltage coupling being electrically coupled to the  
reference voltage conductor of the printed circuit board and the feed coupling being  
5 electrically coupled to the antenna feed conductor.

10. A planar inverted F antenna according to Claim 9 wherein the reference  
voltage coupling is electrically coupled to the reference voltage conductor through an  
electrical short.

11. A planar inverted F antenna according to Claim 9 wherein the reference  
voltage coupling is electrically coupled to the reference voltage conductor through a  
non-zero impedance.

12. A planar inverted F antenna according to Claim 1 wherein the operating  
frequency band comprises a high-frequency band, wherein the planar inverted F  
antenna is further configured for operation at a low-frequency band, wherein the  
current null is present between the feed and reference voltage couplings at the high-  
frequency band, and wherein the current null is not present between the feed and  
20 reference voltage couplings at the low-frequency band.

13. A planar inverted F antenna according to Claim 12 wherein the high-  
frequency band is greater than 1700 MHz and wherein the low-frequency band is less  
than 1100 MHz.

14. A planar inverted F antenna comprising:  
a conductive antenna element;  
a feed coupling on the conductive antenna element; and  
first and second reference voltage couplings on the conductive antenna  
30 element wherein an electrical distance between the feed coupling and either of the  
first and second reference voltage couplings is greater than an electrical distance  
between the first and second reference voltage couplings.

15. A planar inverted F antenna according to Claim 14 wherein the planar inverted F antenna is configured for operation at an operating frequency band and wherein a current null is present on the conductive antenna element between the feed coupling and at least one of the reference voltage couplings at the operating frequency band.

16. A planar inverted F antenna according to Claim 15 wherein the operating frequency band is in the range of approximately 1700 MHz to 2500 MHz.

17. A planar inverted F antenna according to Claim 15 wherein the operating frequency band comprises a high-frequency band, wherein the planar inverted F antenna is further configured for operation at a low-frequency band, wherein the current null is present at the high-frequency band, and wherein the current null is not present between the feed coupling and the at least one of the reference voltage couplings at the low-frequency band.

18. A planar inverted F antenna according to Claim 17 wherein the high-frequency band is greater than 1700 MHz and wherein the low-frequency band is less than 1100 MHz.

19. A planar inverted F antenna according to Claim 14 further comprising: a printed circuit board including a reference voltage conductor and an antenna feed conductor, the first and second reference voltage couplings being electrically coupled to the reference voltage conductor of the printed circuit board, and the feed coupling being electrically coupled to the antenna feed conductor.

20. A planar inverted F antenna according to Claim 19 wherein at least one of the first and second reference voltage couplings is electrically coupled to the reference voltage conductor through an electrical short.

21. A planar inverted F antenna according to Claim 19 wherein at least one of the first and second reference voltage coupling is electrically coupled to the reference voltage conductor through a non-zero impedance.

22. A planar inverted F antenna according to Claim 14 wherein the feed coupling and at least one of the first and second reference voltage couplings are separated by an electrical distance of at least approximately 15 mm.

5           23. A planar inverted F antenna according to Claim 14 wherein the conductive antenna element comprises,

          first and second antenna segments, wherein the first and second antenna segments are spaced apart,

          a third antenna segment coupled between the first and second antenna  
10 segments, and

          wherein the feed coupling and the first and second reference voltage couplings are on the first segment with the feed coupling being between the first and second reference voltage couplings.

15           24. A planar inverted F antenna according to Claim 23 wherein the conductive antenna element further comprises a fourth antenna segment coupled to the first antenna segment.

          25. A planar inverted F antenna according to Claim 24 wherein the fourth  
20 antenna segment is coupled to the first antenna segment adjacent the feed coupling.

          26. A planar inverted F antenna according to Claim 14 wherein the feed coupling is spaced apart from at least one of the first and second reference voltage couplings by an electrical distance of at least approximately 10 mm.  
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          27. A planar inverted F antenna according to Claim 14 wherein the antenna element includes,

          an antenna base with the feed coupling and the first and second reference voltage couplings thereon,

30           a first segment extending from the antenna base adjacent the first reference voltage coupling, and

          a second antenna segment extending from the antenna base adjacent the feed coupling.

28. A communications device comprising:

a transceiver configured to transmit and/or receive radio communications at an operating frequency band, the transceiver providing a reference voltage and a transceiver feed; and

5 a planar inverted F antenna configured for operation at the operating frequency band, the planar inverted F antenna including first and second antenna segments wherein the first and second antenna segments are separated by at least approximately 3 mm, a third antenna segment coupling the first and second antenna segments, a reference voltage coupling on the first antenna segment wherein the  
10 reference voltage coupling of the planar inverted F antenna is coupled to the reference voltage of the transceiver, and a feed coupling on the first antenna segment wherein the feed coupling of the planar inverted F antenna is coupled to the transceiver feed and wherein a current null is present between the feed and reference voltage couplings at the operating frequency band.

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29. A communications device according to Claim 28 wherein the feed and reference voltage couplings are separated by at least approximately 15 mm.

30. A communications device according to Claim 28 wherein the first and  
20 second antenna segments are rectilinear and parallel.

31. A communications device according to Claim 30 wherein the third antenna segment is coupled to the first and second antenna segments at ends of the first and second antenna segments.

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32. A communications device according to Claim 28 wherein the feed coupling is spaced apart from the third antenna segment by a greater distance than the reference voltage coupling.

30 33. A communications device according to Claim 32 wherein the first and the third antenna segments define an angle of approximately 90 degrees.

34. A communications device according to Claim 28 wherein the first antenna segment is longer than the second antenna segment.

35. A communications device according to Claim 28 wherein the operating frequency band is in the range of approximately 1700 MHz to 2500 MHz.

5           36. A communications device according to Claim 28 further comprising:  
a printed circuit board including a reference voltage conductor and an antenna feed conductor, the reference voltage coupling being electrically coupled to the reference voltage conductor of the printed circuit board and the feed coupling being electrically coupled to the antenna feed conductor.

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37. A communications device according to Claim 36 wherein the reference voltage coupling is electrically coupled to the reference voltage conductor through an electrical short.

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38. A communications device according to Claim 36 wherein the reference voltage coupling is electrically coupled to the reference voltage conductor through a non-zero impedance.

20           39. A communications device according to Claim 28 wherein the operating frequency band comprises a high-frequency band, wherein the planar inverted F antenna is further configured for operation at a low-frequency band, wherein the current null is present between the feed and reference voltage couplings at the high-frequency band, and wherein the current null is not present between the feed and reference voltage couplings at the low-frequency band.

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40. A communications device comprising:

a transceiver configured to transmit and/or receive radio communications at an operating frequency band, the transceiver providing a reference voltage and a transceiver feed; and

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a planar inverted F antenna including a conductive antenna element, a feed coupling on the conductive antenna element wherein the feed coupling is coupled to the transceiver feed, and first and second reference voltage couplings on the conductive antenna element wherein the first and second reference voltage couplings are coupled to the reference voltage of the transceiver and wherein an electrical

distance between the feed coupling and either of the first and second reference voltage couplings is greater than an electrical distance between the first and second reference voltage couplings.

5           41. A communications device according to Claim 40 wherein the planar inverted F antenna is configured for operation at an operating frequency band and wherein a current null is present on the conductive antenna element between the feed coupling and at least one of the reference voltage couplings at the operating frequency band.

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          42. A communications device according to Claim 41 wherein the operating frequency band is in the range of approximately 1700 MHz to 2500 MHz.

          43. A communications device according to Claim 41 wherein the operating  
15 frequency band comprises a high-frequency band, wherein the planar inverted F antenna is further configured for operation at a low-frequency band, wherein the current null is present at the high-frequency band, and wherein the current null is not present between the feed coupling and the at least one of the reference voltage couplings at the low-frequency band.

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          44. A communications device according to Claim 40 further comprising:  
a printed circuit board including a reference voltage conductor and an antenna  
feed conductor, the first and second reference voltage couplings being electrically  
coupled to the reference voltage conductor of the printed circuit board, and the feed  
25 coupling being electrically coupled to the antenna feed conductor.

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          45. A communications device according to Claim 44 wherein at least one of the first and second reference voltage couplings is electrically coupled to the reference voltage conductor through an electrical short.

          46. A communications device according to Claim 44 wherein at least one of the first and second reference voltage coupling is electrically coupled to the reference voltage conductor through a non-zero impedance.

47. A communications device according to Claim 40 wherein the feed coupling and at least one of the first and second reference voltage couplings are separated by an electrical distance of at least approximately 15 mm.

5           48. A communications device according to Claim 40 wherein the conductive antenna element comprises,

          first and second antenna segments, wherein the first and second antenna segments are spaced apart,

          a third antenna segment coupled between the first and second antenna  
10 segments, and

          wherein the feed coupling and the first and second reference voltage couplings are on the first segment with the feed coupling being between the first and second reference voltage couplings.

15           49. A communications device according to Claim 48 wherein the conductive antenna element further comprises a fourth antenna segment coupled to the first antenna segment.

          50. A communications device according to Claim 49 wherein the fourth  
20 antenna segment is coupled to the first antenna segment adjacent the feed coupling.

          51. A communications device according to Claim 40 wherein the feed coupling is spaced apart from at least one of the first and second reference voltage couplings by an electrical distance of at least approximately 10 mm.

25           52. A communications device according to Claim 40 wherein the antenna element includes,

          an antenna base with the feed coupling and the first and second reference voltage couplings thereon,

30           a first segment extending from the antenna base adjacent the first reference voltage coupling, and

          a second antenna segment extending from the antenna base adjacent the feed coupling.